Common and uncommon sources of growth in Asia Pacific

Weber, Enzo
Sonderforschungsbereich 649, Humboldt University, Berlin, Germany

September 2006

Common and Uncommon Sources of Growth in Asia Pacific[1]

Enzo Weber

Institut für Statistik und Ökonometrie, Freie Universität Berlin
Boltzmannstr. 20, 14195 Berlin, Germany
eweber@wiwiss.fu-berlin.de
phone: +49 30 838-55792 fax: +49 30 838-54142

First version: 09/2006
This version: 06/2007

Abstract

This paper embarks to analyse the role of exports and investment supposed to be major sources of economic growth in Asia Pacific. Therefore at first, the cointegration properties of exports, capital formation and GDP are examined in vector error correction models (VECMs). The results confirm the crucial role of exports and investment in the Asian growth dynamics. In a second stage, the structural shocks are identified by short- and long-run restrictions. These shocks, as well as the corresponding dynamic responses, are then correlated across all sample countries to provide insight into the depth of regional coherence. At last, the identified trends are explained by various macroeconomic variables.

Keywords: Economic Growth, Structural VECM, Export, Investment, Asia Pacific
JEL classification: O11, F15, C32

[1]This research was supported by the Deutsche Forschungsgemeinschaft through the CRC 649 "Economic Risk". I am grateful to Jürgen Wolters and Cordelia Thielitz for their help. Of course, all remaining errors are my own.

1 Introduction

Since the 1970s, the Asian Pacific region has witnessed an incomparable economic upswing, which has later on been called the "Asian miracle". Countries, which had traditionally relied on policies such as import substitution and national subsistence switched to an enduring export-orientated strategy. This change coincided with the take-off of foreign direct investments mostly conducted by multinational firms intending to tap new markets and striving for profitability increases. In addition, high domestic savings enabling continuous investment were backing the sustained development. Nevertheless, these vibrant dynamics are not common to all the region's nations, thus leaving several economies in a pre-take-off state of relative stagnation. The appearance of severe crises, most recently in 1997/98, additionally harmed the image of self-enduring growth.

The exceptional development dynamics of the last decades are inconceivable without the sustained influence of exports and investment. The close connection of those two growth drivers with technological progress, acquisition of knowledge and market liberalisation set up two major steering forces behind the remarkable economic success, drawing attention of several strands of literature: The role of exports in the Asian economies has been analysed for example by Krueger (1985). Nelson and Pack (1999) provide a critical review on the approaches favouring a key function of capital accumulation in the Asian growth processes. The literature about identifying structural shocks as driving forces is mainly based on the theory of optimal currency areas and was initially influenced by Bayoumi and Eichengreen (1994). These authors specified output and inflation vector autoregressive models in order to isolate one persistent supply and one transitory demand shock, but did not deduce restrictions from the presence of common stochastic trends.

Given the above considerations, I believe it is worthwhile to pursue the following key questions in the present analysis: Is it possible to detect export and investment trends driving the GDP growth dynamics? Which roles can be assigned to each of these trends? Is there any evidence for regional coherence in the sense of similarity between the structural innovations, and what are special characteristics for example of the "Asian tigers"? Finally, which are determinants of the identified trends?

This paper approaches the outlined issues in the context of an empirical time series analysis, which will be proceeded on an aggregated macro-level. The examination works with cointegration restrictions, which are imposed on reduced form VECMs. In this, I explicitly consider the recent structural breaks in the Asian economies. In the second step, long- and short-run restrictions are deduced from the model properties and economic consider-

ations. In the identified model structure, the growth effects are examined using impulse responses and variance decompositions. Additionally, the structural shocks are compared among the nations and explained by relevant macroeconomic variables. Combining this stringent time series analytical framework with an integrated economic approach makes up the contribution of the underlying paper.

In order to knit my research to a theoretical line, I start out to present the basic economic concepts of export and investment dynamics, which underlie my empirical modelling. Section 3 introduces the econometric techniques with emphasis on cointegration and identification. Afterwards, the results of the reduced form and structural models are presented and analysed in section 4. In the end, the summary gives a concluding overview.

2 Economic Foundation

Since the seminal work of Solow (1956), literature on economic growth has mostly concentrated on the determination of steady state paths. Therein, the neoclassical approach stresses, that due to diminishing marginal returns in the aggregate production function deviations from the equilibrium growth rate can only be transitory. Especially, the development of capital accumulation has no long-run effect on growth rates, which are determined by exogenous technological progress. Furthermore, the theory implies convergence of per capita income levels between nations, since less developed countries should achieve higher growth rates. Of course, in case of structural economic parameters differing across countries, convergence would have to be conditioned on these determinants.

As a reaction, the endogenous growth theory, with its origins in Romer (1986) and Lucas (1988), has been developed. Essentially, model-inherent mechanisms prevent the growth rates from falling quasi automatically caused by diminishing marginal returns. The most prominent examples are endogenous technological change and human capital augmentation. As a consequence, the hypothesis of necessary convergence to an exogenously determined steady state path cannot be maintained.

The outstanding development the newly industrialised countries in Asia Pacific have taken in the last decades casts doubt on the implications of the neoclassical approach. However, in an empirical time series context a long-run link between stationary growth rates and non-stationary real investment, as predicted by endogenous growth models, seems rather problematic (see Jones 1995). Notwithstanding the debate on theoretical steady state properties, this paper does not test validity of certain theories, but focuses on the sources

of the partly rapid expansion of income levels in the Asian Pacific region,

In several strands of literature, above all exports and investment have been assumed main sources of the extraordinary Asian Pacific development. The corresponding empirical tests for the most part are based on the concept of Granger causality between measures of output and exports respectively investment (see e.g. Krishna, Ozyildirim and Swanson (1998), or Feasel, Kim and Smith (2001) for a combined analysis). Intending to find out the structural economic forces behind the "Asian miracle" and their regional coherence, apart from GDP I include both real capital formation and exports in structural cointegration models. Naturally, the list of relevant variables could be considerably extended. However, for obvious reasons a complete analysis in an integrated time series model is infeasible. Additionally, the finding of cointegration provides certain robustness against the missing variables problem.

In the following, major theoretical justifications for the important roles of the chosen variables in growth processes are given. First of all, both exports and investment are components of the aggregated demand and therefore have a direct influence on the GDP level. Even though, in an economic growth context it is supply side arguments, which are of decisive importance:

The role of *investment* is closely linked to the main arguments in growth theory: For the neoclassical part, factor endowment accumulation is key variable for catching-up, even though representing only transitory processes. However, the endogenous approach assigns persistent effects to real investment, which generally stem from external effects (see Romer 1986 and Lucas 1988): For example, a higher capital accumulation could trigger further technological progress, resulting in higher productivity. Likewise, the idea of dynamic interaction between physical capital and human resources, comprising abilities, knowledge, experience and social institutions, directs to structural growth effects of investment, which exceed pure moving along the production function. At last, the notion of embodied growth (Solow 1960), stressing that new capital goods bear inherent technological progress, is of straightforward importance. For a debate on factor accumulation and technology as sources of Asian growth see Krugman (1994) and Rodrigo (2000), as well as the references therein.

Most approaches on *export* impacts origin in the theories of growth or development, as elaborated in Lewis (1980), Feder (1982), Helpman and Krugman (1985) and Krueger (1985). First of all, openness to trade is likely to increase the intensity of competition and set economic incentives, thus enhancing efficiency in production and causing sector

reallocation. Contact to the world markets may trigger learning processes and generate knowledge about manufacturing processes, organisation, sales strategies and so on, even though this absorption might require some minimum level of development (e.g. Grossman and Helpman 1991). Furthermore, export strengthening could be a solution to the problem of growth constraints in case of foreign exchange restricting important imports or policy flexibility. At last, scale and specialisation effects are likely to occur as markets expand, so that for example problems of large minimum plant sizes are mitigated.

Of course, it should not be ignored, that in the reverse direction enhanced growth and competitiveness, possibly combined with domestic demand lagging behind, could lead as well to higher exports. In the same line, exports can rise in consequence of production augmented by real investment. The other way round, capital formation might be encouraged in presence both of a reliable foreign demand source and creditworthiness based on sound foreign accounts as well as favourable domestic growth prospects.

In the light of the fore standing arguments I will try to identify the common trends in exports (EXP), gross fixed capital formation (GCF) and gross domestic product (GDP) as generated by export and investment shocks. In this context, innovations with only transitory effects are likely to take the role of demand shocks.

3 Methodological Proceeding

3.1 Reduced Form Models

The basic data generating process in the econometric procedure is the VAR with lag length $q+1$

$$y_t = c_0^* + c_1^* b_t + (c_2^* + c_3^* s_t)t + c_4 d_t + \sum_{i=1}^{q+1} A_i^* y_{t-i} + u_t \ , \tag{1}$$

where y_t contains the n endogenous variables (here EXP, GCF and GDP), A_i^* are $n \times n$ coefficient matrices and u_t is an n-dimensional vector of white noise errors. The deterministic terms are constant, linear trend (t), level breaks (b_t) and trend shift (s_t), as well as impulse and centred seasonal dummies (d_t).

Before proceeding, assume that a unit root process is an acceptable description of the per capita GDP behaviour. According to Johansen (1995), the commonness of $n-r$ stochastic

trends is reflected by a reduced rank of $A^*(1)$, with $A^*(L) = I_n - \sum_{i=1}^{q+1} A_i^* L^i$. Consequently, one can write $A^*(1) = -\alpha\beta'$, where β spans the space of the r cointegrating vectors, and α contains the corresponding adjustment coefficients. Granger's representation theorem leads to the VECM

$$\Delta y_t = \alpha[\beta' y_{t-1} + c_0 + c_1 b_{t-1} + (c_2 + c_3 s_{t-1})(t-1)] + c_4 d_t + \sum_{i=1}^{q} A_i \Delta y_{t-i} + u_t \ , \qquad (2)$$

with $A_i = -\sum_{j=i+1}^{q+1} A_j^*$, $i = 1, \ldots, q$. This representation assumes that constant, trend and shifts are absorbed in the cointegrating relation. In case of empirically insignificant shifts, these are left out in the empirical procedure due to co-breaking in the underlying time series. Note that in (2) lagged intervention dummies, which condition the likelihood function in each subsample (defined by the break dates), as in Johansen et al. (2000), are not displayed for simplicity.

3.2 Trend Analysis

3.2.1 Unit Root Tests

The unit root behaviour of the non-breaking series is checked by ADF tests (see e.g. Dickey and Fuller 1979), including constant, trend and centred seasonal dummies. Here, as well as in all subsequent models, the lag length is set following the usual information criteria (maximum lag 10) and autocorrelation tests. Simulated critical values for the null hypothesis of non-stationarity are taken from Davidson and MacKinnon (1993).

Various authors found, that the presence of structural breaks distorts the unit root test results, see i.e. Perron (1989). Certainly, there is no doubt, that such shifts have recently occurred in Asia Pacific. Here, I follow Saikkonen and Lütkepohl (2002), who propose first estimating the deterministic nuisance parameters and afterwards testing the residuals for non-stationarity. Accordingly, in the first step a GLS regression of the time series on constant, trend, dummies and shifts is run. As in the case of Asia Pacific, the dates, where shifts have occurred, can quite easily be determined both graphically and economically, I assume the break points to be known a priori; endogenous determination for instance by grid search methods would however not decisively change the specifications. In the second step, an ADF type test on the estimated residuals is performed. For critical values of the t-statistic and additional correction terms in the regression see Lanne et al. (2002).

3.2.2 Cointegration Analysis

Johansen (1994, 1995) provides a test for cointegration in the VECM in (2), Johansen et al. (2000) incorporate structural breaks. Their likelihood ratio trace test statistic for the null hypothesis of at most r cointegrating relations is given by

$$\Lambda(r) = -T \sum_{i=r+1}^{n} log(1 - \hat{\lambda}_i) \ , \tag{3}$$

where n is the number of endogenous variables and T the number of observations. $\hat{\lambda}_i$ denotes the i-th largest squared sample canonical correlation between Δy_t and the respective cointegrating relation, both corrected for the influence of the remaining regressors. Critical values are obtained by computing the response surfaces in Doornik (1998), or Trenkler (2004) in case of breaks. Since for some countries, available times series are relatively short (see last column in Appendix Table 13), I implement a small sample correction of the test statistic based on the response surface analysis in Cheung and Lai (1993).

3.3 Identification

From equation (2) it can be seen, that due to the lack of structure, the residuals in u_t do not represent the economically interpretable innovations. The absence of explicit contemporaneous effects between the endogenous variables makes the error terms linear combinations of the underlying structural shocks. Formally, this is

$$u_t = Be_t \ , \tag{4}$$

where B contains the n^2 simultaneous impact coefficients, and e_t represents the vector of structural disturbances. Normalising the variances of e_t to one and assuming zero cross-correlations yield $n + n(n-1)/2 = n(n+1)/2$ different equations, still leaving $n^2 - n(n+1)/2 = n(n-1)/2$ restrictions to impose for the identification of the B matrix. This is exactly the number of *different* instantaneous covariances.

From the VECM moving average representation (Johansen 1995) one gets the matrix of the long-run effects of the reduced form residuals u_t:

$$\Xi = \beta_\perp(\alpha'_\perp(I_n - \sum_{i=1}^{q} A_i)\beta_\perp)^{-1}\alpha'_\perp \ , \tag{5}$$

with $\perp$ denoting the orthogonal complement (thus $\alpha'\alpha_\perp = 0$, where both α and $\alpha_\perp$ have full column rank). Accordingly, the long-run matrix associated to e_t results as ΞB. From the cointegration properties it is known, that at most r shocks have only transitory effects. Setting r columns of ΞB to zero thus produces $r(n-r)$ independent restrictions, since ΞB has only the reduced rank of $n-r$. Therefore, identification is completed by $n(n-1)/2 - r(n-r)$ additional restrictions, of which $r(r-1)/2$ must disentangle the transitory shocks (Gonzalo and Ng 2001). Once the structural coefficients are identified, they provide the base for impulse responses and forecast error variance decompositions (FEVD), which are estimated by the usual recursive calculations of the vector moving average representation.

4 Empirical Evidence

4.1 Data

Country by country, this paper aims at identifying the growth impacts on GDP, which stem from exports and gross fixed capital formation. Including other variables, like human capital or FDI, might be desirable, but is prohibited by the lack of data of sufficient length and frequency. All the quarterly data have been taken from the EcoWin, IMF IFS, OECD and CEIC databases. The series have been transformed as follows: Per capita levels have been calculated by dividing by total population, which was linearly interpolated to gain quarterly data. The nominal data have been deflated to the 2002 level using the implicit price deflators for exports, capital formation and GDP, or, where not available, only the GDP deflator respectively the consumer price index. At last, the 2002 purchasing power parity conversion factors from the international comparison program of the World Bank have been employed to transform all series into US dollar.[2] The calculated variables can be interpreted as the per quarter amount of dollars one would have needed in the USA in 2002, to reach the same level as in the respective country and period.

Figure 1 gives an overview of the time series from the respective starting points till the end of 2005. Several characteristics shall be emphasised: The sample can be split into the industrialised countries Australia, Hong Kong (Special Administrative Region of China), Japan, South Korea ("Korea" in the following), New Zealand, Singapore and Taiwan, and the more or less fast developing countries Indonesia, Malaysia, the Philippines

[2]For Taiwan, the factor has been calculated by a PPP update based on the 1990 relative price from Penn World Table.

and Thailand. In most cases, exports exceed investment in terms of magnitude. While Hong Kong, Malaysia and Singapore exhibit the largest export shares, the economies of Australia, Japan and Korea seem to rely more on domestic capital formation. Severe effects of the 1997/98 Asian crisis can be detected in the series of Hong Kong, Indonesia, Korea, Malaysia, Singapore and Thailand, countries known for having struggled the most by the time; in general, exports are less affected than GDP and GCF. The economic crisis in the early 1980s shows impacts mostly on Australia, Hong Kong, the Philippines and Singapore.[3] Regarding the Oceanic countries Australia and New Zealand, there appears a growth weakness around 1992, which coincides with a general world economic downturn. In Japan, the economic boom of the late 1980s is visible just as the long period of deflationary recession. The various economic disruptions give ground to formally incorporate structural breaks, see Appendix Tables 12 and 13.

Finally, I provide formal tests for the presence of unit roots in the series: Appendix Table 12 displays the ADF statistics, or, where breaks have been considered, the Saikkonen and Lütkepohl (2002) statistics. In none of the cases, the null hypothesis of non-stationarity can be rejected at the 10% level. As additionally, the first differences are clearly stationary, I assume the series integrated of order one. All calculations in this paper have been carried out in JMulti 4, EViews 5 and Gauss 8.

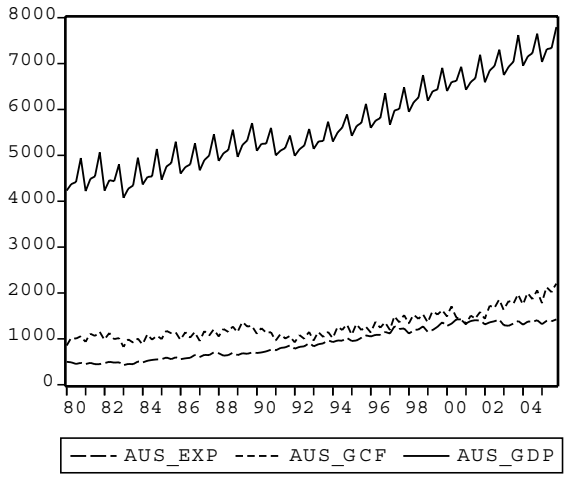
4.2 Long-Run Model Properties

As I have established non-stationarity of exports, investment and GDP in all countries under consideration, connections in stochastic trending are decisive for long-run growth dynamics. Therefore, I proceed with determining the number of common trends in all trivariate VECMs from (2). For this reason, Table 1 displays the trace test statistics for the hypotheses of $r = 0$ and $r = 1$. The former can be rejected in all cases at least at the 5% level, but more than one cointegrating vector is not within reach. Note that critical values depend on the respective model deterministics, see Appendix Table 13.

	AUS	HK	IDN	JPN	KOR	MAL	NZL	PLP	SGP	THL	TWN
$H_0 : r = 0$	46.2*	77.2**	33.7*	65.5*	52.3**	48.6*	49.4*	53.0**	46.5*	49.0**	64.8**
$H_0 : r = 1$	22.1	28.0	15.0	33.8	21.9	11.8	27.1	25.4	17.8	17.9	18.3
** , * : H_0 can be rejected at 1% respectively 5% significance level											

Table 1: Trace test statistics

[3] Of course, various series had not even begun in the early 1980s.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7000
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5000
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3000
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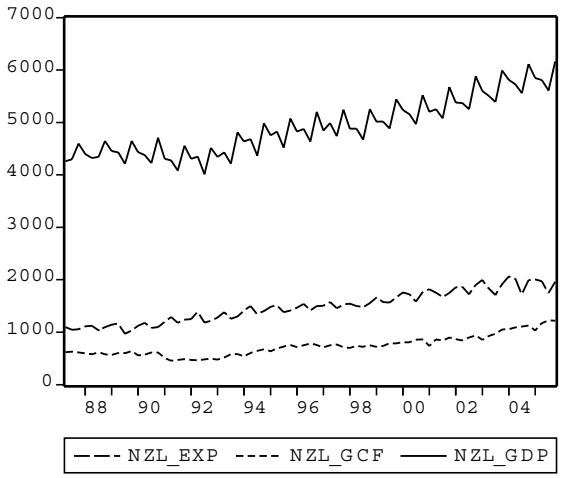
80 82 84 86 88 90 92 94 96 98 00 02 04
AUS_EXP AUS_GCF AUS_GDP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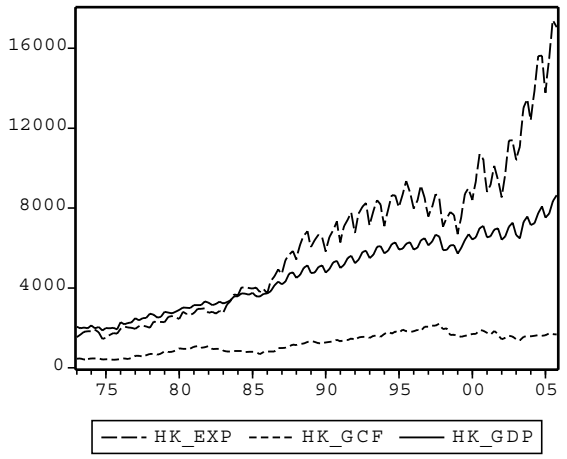
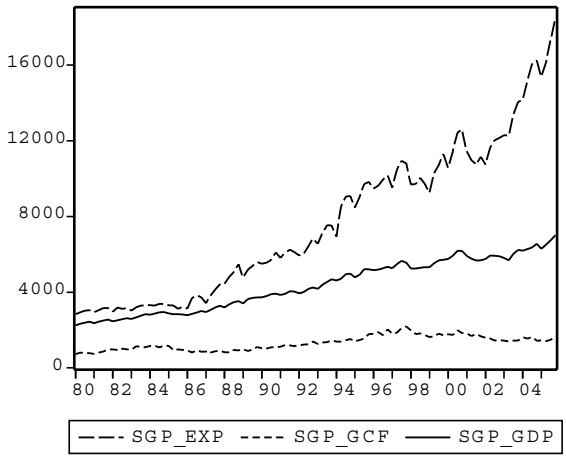
88 90 92 94 96 98 00 02 04
NZL_EXP NZL_GCF NZL_GDP


16000
12000
8000
4000
0
75 80 85 90 95 00 05
HK_EXP HK_GCF HK_GDP


16000
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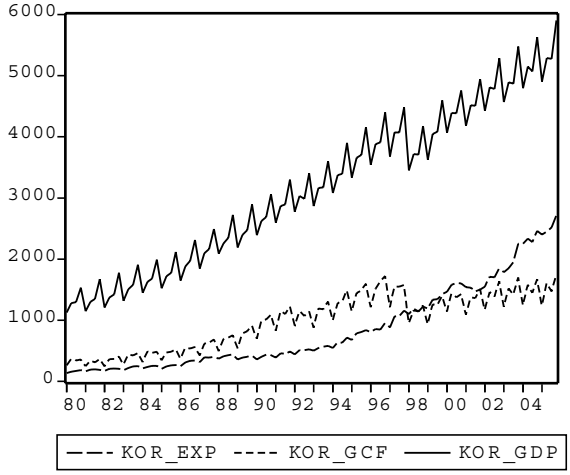
80 82 84 86 88 90 92 94 96 98 00 02 04
SGP_EXP SGP_GCF SGP_GDP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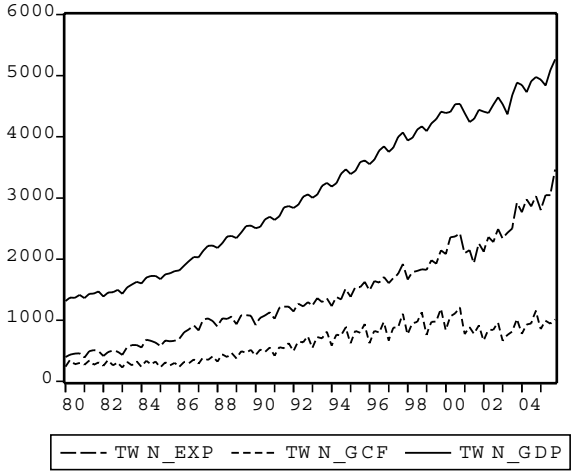
80 82 84 86 88 90 92 94 96 98 00 02 04
KOR_EXP KOR_GCF KOR_GDP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80 82 84 86 88 90 92 94 96 98 00 02 04
TWN_EXP TWN_GCF TWN_GDP

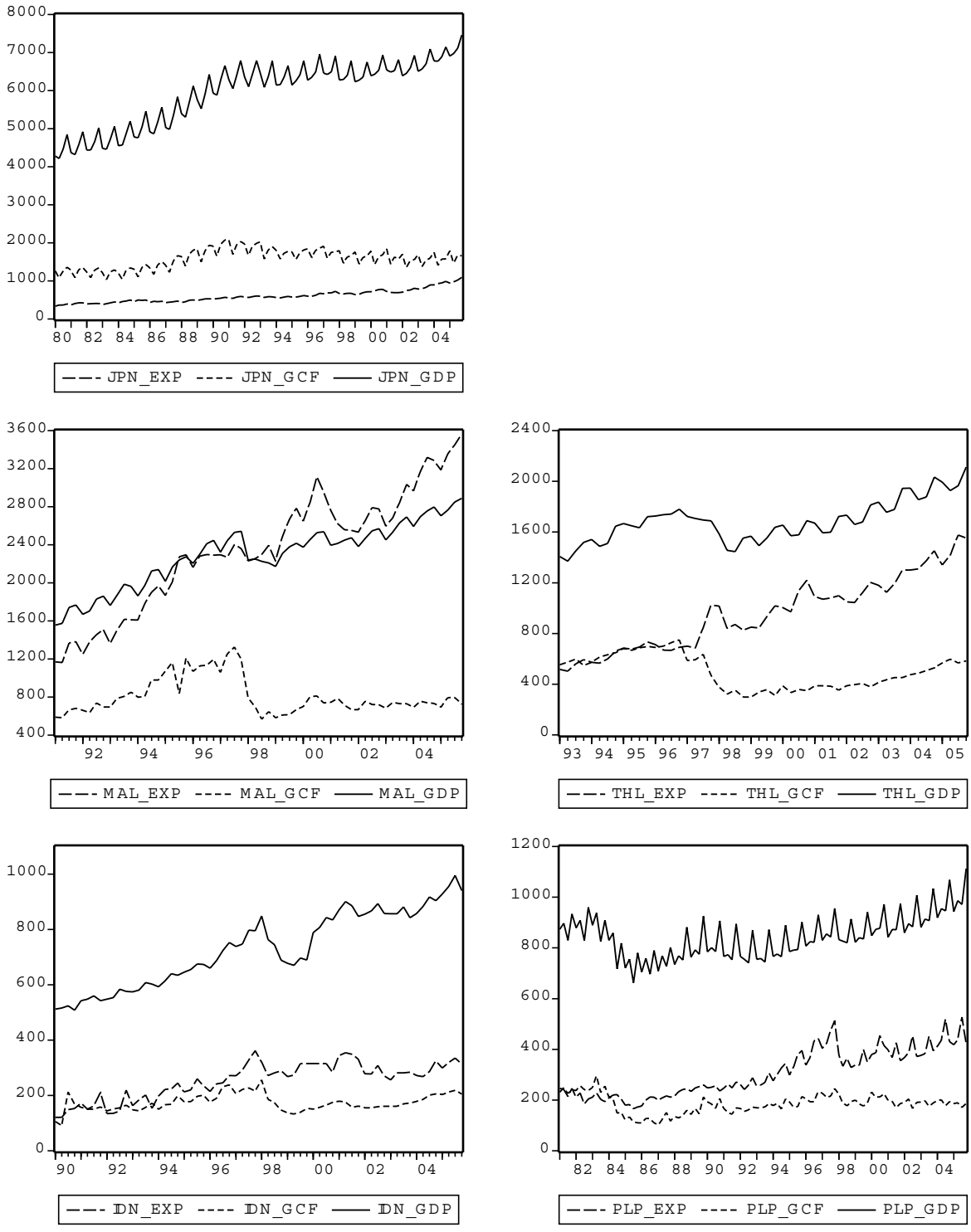

Figure 1: Exports, Gross Fixed Capital Formation and GDP (2002 p.c. PPP US $)

Consequently, all VECMs are estimated including one error correction term. The models have been checked to pass the Jarque-Bera test and a Lagrange multiplier test for serial correlation, results are available on request. The full specifications including the brake dates can be found in Appendix Table 13. Table 2 lists the cointegrating vectors for further interpretation: The relatively low standard errors indicate, that all variables are necessary elements in the respective equilibrium relations.[4] Except for the Philippines, the GDP coefficient is the only one to carry a negative sign; in the long-run relation, GDP left hand side thus equals a linear combination of exports and investment right hand side. This leads to the interpretation, that both EXP and GCF contain an idiosyncratic stochastic trend, and that these trends both drive the GDP growth; further evidence will be provided below. The high estimates for coefficients of Hong Kong, Malaysia, Singapore and Taiwan are presumably attributable to their strong export performance.

	AUS	HK	IDN	JPN	KOR	MAL	NZL	PLP	SGP	THL	TWN
EXP	1	1	1	1	1	1	1	1	1	1	1
GCF	0.80	0.56	1.53	0.96	1.76	2.41	1.08	-1.88	2.99	0.63	4.15
	(0.24)	(0.29)	(0.52)	(0.23)	(0.11)	(0.36)	(0.22)	(0.36)	(1.09)	(0.06)	(0.76)
GDP	-0.80	-3.64	-0.45	-0.88	-2.11	-4.90	-1.03	0.49	-9.04	-0.94	-3.44
	(0.13)	(0.26)	(0.10)	(0.16)	(0.17)	(0.63)	(0.13)	(0.14)	(1.19)	(0.05)	(0.67)
standard errors in parentheses											

Table 2: Cointegrating vectors

Having defined the long-run relations, I now turn to the question of equilibrium adjustment, which is obviously a crucial one in the given growth context. As can be seen in Table 3, the reaction of GDP to equilibrium deviations is always positive[5] and clearly significant, lending support to the interpretation of growth driving trends in exports and investment, which in turn reveal mostly negligible reactions. Exports do not adjust significantly (and correctly) but in Hong Kong, Japan and Thailand. For the two former, this might reflect the economic strength of their trade-orientated sectors, since otherwise, export-governing impulses would predominantly originate in foreign sources. The same countries surprisingly are those with significant and wrong-directed adjustment of GCF. A reverse pattern is found for Singapore, where GCF instead of EXP adjusts in line with

[4]Using different normalisations, this holds as well for the EXP parameters, and applying Wald tests to zero restrictions on the cointegrating vectors does not change the results. The export normalisation is just to avoid small numbers and allows for estimating standard errors of the GDP parameters.

[5]Sensible system re-equilibration requires opposite signs of cointegrating and adjustment parameters belonging to the same variable.

the expectations. Of course, the theory of two stochastic trends belonging to the export and investment dynamics fits best to the cases, where these two variables are weakly exogenous. Otherwise, the interpretation has to be completed with spillback effects, but in presence of significant GDP adjustment it is still appealing.

As the only country, the Philippines deviate substantially from the established systematic functioning: While GDP enters the error correction term with a positive sign, it also reacts positively to equilibrium deviations. Qualitatively, this finding is not sensitive to different model specifications, estimation procedures and sample periods. The main reason is probably the very low GCF performance (see Figure 1), which makes it impossible to extract a positive impact on GDP.

	AUS	HK	IDN	JPN	KOR	MAL	NZL	PLP	SGP	THL	TWN
EXP	0.01	-0.22	-0.03	-0.12	0.04	-0.07	-0.10	-0.01	0.12	-0.35	0.06
	[0.74]	[-2.55]	[-1.03]	[-3.82]	[1.84]	[-1.15]	[-0.61]	[-0.46]	[4.93]	[-2.87]	[0.75]
GCF	0.01	0.07	-0.04	0.24	0.04	-0.07	0.09	-0.01	-0.02	0.45	0.05
	[0.48]	[3.12]	[-1.60]	[2.84]	[1.32]	[-1.57]	[0.77]	[-0.28]	[-3.48]	[4.08]	[1.22]
GDP	0.35	0.13	0.12	0.53	0.23	0.09	0.82	0.12	0.03	0.31	0.12
	[7.76]	[3.58]	[5.29]	[4.46]	[8.52]	[3.35]	[4.37]	[5.40]	[3.81]	[2.94]	[2.28]
t-values in brackets											

Table 3: Adjustment parameters

4.3 Structural Growth Models

In section 4.2, I have established two common stochastic trends each in all trivariate national systems. While this already provides interesting insight into qualitative long-run dependences, determining growth effects quantitatively requires tying down the structural model form. To identify the underlying shocks, I first exploit the reduced-rank properties by restricting the long-run impact of one shock to zero, thus interpreting it as demand innovation. As this provides two linearly independent restrictions, following the criterion from section 3.3, one more is needed for full identification.

In the growth-orientated analytical frame, it would surely be inconsistent to impose further long-run constraints. Therefore, I adopt the most sensible assumption about contemporaneous impacts: Clearly, as components of GDP, both export and investment must have simultaneous effects on income, which are to be estimated. By the same token, it seems unreliable to restrict the contemporaneous reaction of GCF, because investment

is normally seen as reacting quite quickly to news giving ground to profit expectations. Maintaining linear independence, the remaining alternative is to constrain the contemporaneous impact of investment on exports to zero: First, the settling process of new capital is typically characterised by delays, and second, exports depend at least in the short-run mainly on foreign influences. Furthermore, the lowest residual cross-correlations exist between GCF and EXP, averaging to 0.18 through all eleven models.

Before proceeding, all insignificant parameters have been sequentially eliminated in order to enhance efficiency and to avoid disturbing the residuals, which shall form the series of structural shocks. The (accumulated) residual plots and the corresponding GDP impulse responses can be found in Appendix Figures 2 and 3. As summary measures, Table 4 includes the structural long-run effects ΞB of unit shocks in export and investment on GDP (measured as usually in 2002 per capita PPP US $). The standard errors in parentheses are computed in bootstrap procedures with 3.000 replications. Basically all long-run coefficients are clearly significant and, with three exceptions, positive. The last row (FEVD) adds the long-run contributions of EXP and GCF to GDP forecast error variance.

In most countries, the investment shocks bring about higher growth effects than the export shocks. This is especially true for the industrialised economies of Japan, Korea, New Zealand and Taiwan and can as well be seen in the FEVD relations. Exceptions are Australia, which - as a small country - exports high amounts of raw materials, and Thailand, which is known to depend heavily on exports. The negative GCF parameters for Hong Kong and Singapore are probably caused by the weak investment, above all in the phase of corporate and financial restructuring after the Asian crisis, contrasting with the enormous export performance (see as well Figure 1). The still low export parameters can be rationalised by taking into account, that the nearly explosive export figures in the two city states go hand in hand with similar import development and can impossibly affect GDP one by one in simple national accounting. As a general result, exports of developing countries tend to have higher growth impacts than in matured economies. An appealing interpretation is, that nations with non-settled enclave-like technology sectors depend more on foreign impulses than countries with broad and deep industrial structures. Put it the other way round, outward orientation obviously is highly effective in catching-up processes. Recalling the explanations from section 4.2, again the Philippine coefficients are at odds with the overall results, but are actually reflecting the economy's stagnating course of the last decades.

The analysis of structural effects is completed by addressing the transitory demand shocks.

	AUS	HK	IDN	JPN	KOR	MAL	NZL	PLP	SGP	THL	TWN
EXP	1.16	0.20	0.69	0.80	0.41	0.23	0.27	1.10	0.18	1.15	0.59
	(0.15)	(0.04)	(0.16)	(0.43)	(0.21)	(0.05)	(0.09)	(0.49)	(0.03)	(0.27)	(0.18)
GCF	0.99	-0.83	1.33	2.27	0.85	0.32	0.92	-1.65	-0.13	0.94	1.24
	(0.12)	(0.22)	(0.25)	(0.61)	(0.19)	(0.04)	(0.12)	(0.69)	(0.11)	(0.29)	(0.32)
FEVD	39/61	71/29	28/72	8/92	11/89	33/67	15/85	39/61	83/17	76/24	38/62
standard errors in parentheses FEVD: long-run contributions (%) of EXP resp. GCF to GDP variance											

Table 4: GDP long-run effects of structural export resp. investment unit shocks

Table 5 provides the number of quarters with significant[6] GDP impulse responses as well as the long-run *accumulated* GDP effects (in 2002 per capita PPP US $). All measures keep within the bounds, which are implied by the interpretation of the identified shock as demand innovation. In Australia, Indonesia, the Philippines and Thailand these disturbances are most important and persistent.

	AUS	HK	IDN	JPN	KOR	MAL	NZL	PLP	SGP	THL	TWN
Duration (quarters)	26	5	19	2	5	2	5	23	9	12	6
Accumul.Responses	4.28	0.02	4.26	2.41	3.51	1.04	1.41	22.76	1.68	6.59	2.47

Table 5: GDP impulse responses to structural demand unit shocks

4.4 Regional Coherence

Besides identifying growth sources country by country, a regional perspective on economic development seems promising. For this sake, Tables 6, 7 and 8 present cross-country correlations among the structural shocks in the lower left and among the GDP impulse responses in the upper right triangles. The former give an impression of the coherence of structural innovations the countries are subject to. The latter then provide information, on which degree the shocks are processed symmetrically within the different economies. The impulse responses have been calculated for the first 30 quarters, capturing all relevant developments. Varying the end point has only negligible effects.

Evidently, the strongest correlations exist between the export innovations: The main cluster consists of Hong Kong, Japan, Malaysia, Korea, Taiwan and Thailand, among which the bulk of correlations is significantly positive with a mean exceeding 0.25. This defini-

[6]Significance is assessed by bootstrapping 95% confidence intervals (Hall 1992) with 3.000 replications.

tion roughly corresponds to the group of newly industrialised "Asian tigers", even though Singapore does not significantly correlate but with Taiwan. These connections could for example be explained by the development of transnational production and trade networks (see e.g. Kimura 2006) as well as common dependences on foreign demand. Another cluster could possibly comprise Australia, Indonesia and the Philippines. However, the impulse responses are most in line within the group of Australia, Indonesia, Malaysia, the Philippines, Singapore and Thailand (mean correlation = 0.86), Korea might be added. While this unites all less developed countries, the negative correlations including Hong Kong and Japan are a product of high impact multipliers going down in the following periods.

	AUS	HK	IDN	JPN	KOR	MAL	NZL	PLP	SGP	THL	TWN
AUS	×	-0.29	0.99**	-0.91**	0.41**	0.73**	-0.34*	0.93**	0.93**	0.99**	0.06
HK	0.17*	×	-0.26	0.45**	-0.33*	-0.15	-0.12	-0.34*	-0.08	-0.26	-0.13
IDN	0.27**	-0.15	×	-0.88**	0.38**	0.75**	-0.30	0.91**	0.97**	1.00**	0.04
JPN	0.08	0.25**	-0.06	×	-0.38**	-0.68**	0.46**	-0.79**	−0.89**	-0.88**	-0.08
KOR	0.01	0.19*	-0.12	0.24**	×	-0.07	-0.06	0.55**	0.37	0.38**	0.03
MAL	0.29**	0.41**	0.00	0.36**	0.19*	×	-0.35*	0.47**	0.83**	0.74**	0.31*
NZL	0.11	0.13	0.01	-0.11	0.12	-0.02	×	-0.14	-0.31*	-0.29	-0.20
PLP	0.16	0.17*	0.24*	0.13	-0.00	0.10	0.13	×	0.81**	0.91**	-0.09
SGP	0.12	0.08	-0.10	0.15	-0.09	0.08	-0.22*	0.08	×	0.97**	0.00
THL	0.07	0.45**	0.13	0.19	0.05	0.32**	0.16	0.20	0.05	×	0.03
TWN	-0.07	0.28**	-0.21	0.22**	0.10	0.24**	-0.05	0.11	0.20**	0.23*	×
** , * : significant at 5% respectively 10% level											

Table 6: Correlations: export shocks (lower left), GDP responses (upper right)

With a mean correlation of 0.04, evidence for coherence is weakest among the investment shocks. Apart from several correlations often involving Malaysia, no significance can be detected. Nevertheless, the reactions to GCF shocks follow a fairly symmetric course: Only Hong Kong, Singapore and the Philippines, the three countries, which are subject to negative long-run effects, deviate substantially from the normal adjustment pattern; with a mean of 0.71 though, correlations are highest among Australia, Indonesia, Japan, Malaysia, Thailand and Taiwan.

The demand shock correlations average to only 0.04, but evidently, many negative values belong to developing countries. Indeed, one cluster might be found containing the industrialised nations (mean correlation = 0.16, without Singapore). In this, it should be

	AUS	HK	IDN	JPN	KOR	MAL	NZL	PLP	SGP	THL	TWN
AUS	×	-0.55**	0.62**	0.50**	0.17	0.51**	0.11	-0.47**	-0.70**	0.69**	0.44**
HK	-0.07	×	-0.75**	-0.80**	-0.24	-0.39**	-0.31*	0.69**	0.90**	-0.85**	-0.89**
IDN	-0.08	-0.09	×	0.86**	0.24	0.84**	0.29	-0.80**	-0.91**	0.96**	0.81**
JPN	-0.03	0.04	-0.00	×	0.17	0.59**	0.47**	-0.73**	-0.88**	0.89**	0.91**
KOR	-0.06	-0.10	0.06	-0.04	×	0.46**	0.14	0.17	-0.11	0.13	0.20
MAL	0.03	-0.25*	0.23*	-0.07	0.24*	×	0.15	-0.42**	-0.58**	0.68**	0.49**
NZL	0.16	-0.19	0.16	0.03	0.13	0.30**	×	-0.18	-0.35*	0.32*	0.21
PLP	−0.21*	-0.06	0.04	0.10	0.10	0.26**	0.12	×	0.83**	-0.86**	-0.77**
SGP	-0.01	0.08	-0.07	-0.08	-0.01	0.22*	0.16	0.19*	×	-0.99**	-0.85**
THL	0.11	0.06	-0.11	0.13	0.11	0.06	-0.11	0.15	0.19	×	0.86**
TWN	0.04	-0.01	0.11	-0.26**	-0.15	0.07	-0.04	0.06	0.30**	0.22	×
** , * : significant at 5% respectively 10% level											

Table 7: Correlations: investment shocks (lower left), GDP responses (upper right)

considered, that my models do not include any nominal variables, which are normally seen as predestined for identifying structural demand innovations (e.g. Bayoumi and Eichengreen 1994). The responses to the transitory shocks are highly coherent, resulting in a mean correlation of 0.60; significantly lower values could at most be detected for Hong Kong and the Philippines. Though, the interpretation should take into account, that the zero long-run restrictions naturally contribute to high impulse response correlations.

4.5 Explaining Shocks

In continuation, I aim at finding evidence for connections between important model-exogenous macro variables and the identified structural shocks. This is done by accumulating the shocks, thus producing random walk or stochastic trend series, and then testing for cointegration. The corresponding model specifications including lag lengths and break dates are available from the author upon request. In most cases, the additional series prove to be weakly exogenous, thus "explaining" variables. Nonetheless, in view of the interdependences in a (growing) economic system, the finding of several feedback relations comes not as a surprise. Note that linking explanation variables to the shocks does of course not question the assumption of independent distribution from section 3.

For explaining export shocks, intuitive candidates are foreign incomes and exchange rates. Table 9 shows the p-values of the trace tests between the respective export trends and the

	AUS	HK	IDN	JPN	KOR	MAL	NZL	PLP	SGP	THL	TWN
AUS	×	0.44**	0.91**	0.92**	0.78**	0.91**	0.71**	0.50**	0.73**	0.90**	0.63**
HK	0.10	×	0.40**	0.32*	0.51**	0.53**	0.81**	-0.23	0.32*	0.40**	0.65**
IDN	-0.06	-0.11	×	0.72**	0.88**	0.77**	0.59**	0.51**	0.94**	1.00**	0.66**
JPN	-0.05	0.15	-0.03	×	0.58**	0.85**	0.69**	0.45**	0.49**	0.69**	0.53**
KOR	0.09	0.10	0.22*	0.12	×	0.78**	0.64**	0.18	0.82**	0.88**	0.54**
MAL	-0.02	0.17	-0.13	-0.22*	-0.10	×	0.73**	0.17	0.53**	0.76**	0.48**
NZL	0.17	0.22*	0.01	0.20*	0.18	0.04	×	0.05	0.43**	0.58**	0.74**
PLP	-0.02	-0.02	-0.23*	0.12	0.23**	-0.14*	0.20*	×	0.48**	0.50**	0.19
SGP	0.08	-0.06	-0.12	-0.10	-0.11	0.09	-0.05	0.11	×	0.95**	0.68**
THL	-0.05	0.03	-0.19	-0.24*	0.04	0.05	0.19	0.20	0.04	×	0.66**
TWN	0.07	0.34**	-0.10	0.11	0.15	0.11	0.35**	0.17*	-0.08	-0.02	×
** , * : significant at 5% respectively 10% level											

Table 8: Correlations: demand shocks (lower left), GDP responses (upper right)

real per capita GDPs of Japan, Euroland (Eurostat, seasonally adjusted, starting 1980) and the USA (Dept. of Commerce), as well as the real effective exchange rates (J.P. Morgan).[7] Summarising the figures, exports are determined by the US GDP, followed by Euroland and Japan. Indonesia, Malaysia and Thailand yield the weakest evidence. Furthermore, the exchange rates exhibit the closest connections to the exports of the smaller or currently not matured economies.

	AUS	HK	IDN	JPN	KOR	MAL	NZL	PLP	SGP	THL	TWN
JPN	0.23	0.02	0.16	–	0.03	0.16	0.04	0.41	0.23	0.57	0.61
Euro	0.23	0.09	0.82	0.07	0.06	0.31	0.14	0.06	0.19	0.78	0.15
USA	0.07	0.12	0.28	0.00	0.00	0.57	0.01	0.02	0.06	0.56	0.02
REER	0.89	0.03	I(0)	0.86	0.20	0.00	0.09	I(0)	0.16	I(0)	0.02

Table 9: Trace test p-values: export trends vs. foreign incomes resp. exchange rates

Capital formation is likely to depend on profit expectations, here represented by the indexed share prices from the main national stock exchanges, and interest rates as opportunity costs (long-term government bond yields or similar rates if not available). Interpreting Table 10 reveals the strong connection of investment with share prices in most industrialised countries. The contrary result for Hong Kong is not curious, because its extreme openness and its role as an international stock market could disconnect the Hang

[7] In case of stationarity, no p-value is reported.

Seng from domestic investment; see as well the wrong-directed adjustment in Table 3. The linkage between capital formation and bond yields is relatively well developed. In Japan, it has probably weakened during the long deflationary period marked by ineffective interest rate lowering, and Singapore is known not relying on bond financing. Since national stock markets are likely following strong idiosyncratic determinants, and the interest rate linkages in the Asian Pacific region are not very close (e.g. Eichengreen and Park 2004), in this light the weak relations between the investment shocks (Table 7) do not come as a surprise.

	AUS	HK	IDN	JPN	KOR	MAL	NZL	PLP	SGP	THL	TWN
share	0.06	0.63	0.01	0.00	0.06	0.01	0.00	0.47	0.04	0.34	0.77
interest	0.06	0.06	0.00	0.46	0.03	0.34	0.11	0.10	0.93	0.02	0.83

Table 10: Trace test p-values: investment trends vs. share prices resp. interest rates

Addressing the aggregate demand shocks, compelling explanatory power can be expected in the main macroeconomic policy variables, public expenditure (per capita real government consumption) and money (per capita real M3; M2 where not available). Indeed, for most countries at least one of the tests in Table 11 is in favour of cointegration. Bearing in mind the demand correlation cluster from Table 8, the interpretation of a relatively consistent macroeconomic policy among the industrialised countries seems appealing. The remaining variation is left to be explained by other sources, probably private aggregate demand.

	AUS	HK	IDN	JPN	KOR	MAL	NZL	PLP	SGP	THL	TWN
G	0.03	0.18	0.01	0.08	0.10	0.28	0.08	0.04	0.42	0.09	0.83
M3	0.62	0.03	0.01	0.61	I(0)	0.36	0.03	0.01	0.08	0.25	0.43

Table 11: Trace test p-values: demand trends vs. government consumption resp. M3

5 Concluding Summary

Guided by the task to shed light on the Asian Pacific economic growth process, this paper focused on the role of exports and investment. Including these variables together with GDP in cointegrating systems led to estimations of dynamic impacts, which underlie the impressive economic development. Furthermore, the explicit identification of the structural shocks allowed comparing and explaining the major driving forces of the different economies in an aspiring region.

In all considered countries, the three-dimensional systems of GDP, exports and gross fixed capital formation could be shown containing two common stochastic trends. The cointegrating vectors and the highly significant GDP adjustment parameters support the view of one export and one investment trend driving the income growth dynamics. On the one hand, this is consistent with the export-led growth hypothesis, which has especially gained relevance in the South-East Asian industrialisation, while on the other hand, it underpins the crucial importance of capital accumulation for economic progress.

Imposing short- and long-run restrictions allowed the identification of two persistent growth shocks as well as one transitory demand shock. In almost all cases, the former have a positive and significant effect on the long-run GDP level. Thereby, developing countries tend towards a dominant role of exports, whereas growth in industrialised nations gains more from investment impulses. Apart from that, the demand shocks initiate positive GDP effects with sensible durations.

Subsequently, economic coherence in the Asian Pacific region has been analysed. While the structural investment shocks exhibit strong idiosyncratic components, I was able to identify clusters of countries subject to resembling export and demand disturbances. With this investigation directing at the pure *presence* of related shocks, the question of symmetric *reactions* can be incorporated by correlating the corresponding impulse responses. These calculations yielded a high degree of symmetry, but also a few interesting exceptions concerning above all Hong Kong, the Philippines and Japan.

In order to uncover systematic connections of the structural innovations, in the last step, I tested for cointegration with several macroeconomic variables. In particular, export shocks seem largely determined by exchange rates and foreign income. In this, the USA proved slightly more important than Euroland and Japan. For investment and demand trends, significant cointegration could be frequently established with share prices and interest rates, respectively government consumption and money.

In an attempt to grasp the "Asian miracle" of powerful economic growth, two major sources come to the fore within a mixture of impulses from the outside industrialised world as well as domestic dynamics, in fashion of exports and investments. Furthermore, several features of economic growth are shared in the Asian Pacific region. This implies, that amongst others, policies aiming at free trade, capital market deepening, transnational investment and monetary cooperation, as well as sustainable development, should be constructed along these lines. For example, one should take into account investment effects of interest rates as instruments of foreign exchange management, the importance

of exports in regional and world trade liberalisation, and the role of capital stocks and flows in the building of sound domestic and international financial systems. Besides these second-step policy implications, one should be aware, that past growth trends are not to be simply extrapolated, making it necessary to continue in exhausting new potentials of progress.

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Appendix

	EXP	lags	shifts	GCF	lags	breaks	GDP	lags	breaks
AUS	-1.61	4		-0.30	5		-0.80	4	
HK	-1.87	6	00:3 T	-1.87	7	98:1	-2.34	8	98:1
IDN	-2.98	0		-0.74	0	98:2	-2.58	5	98:2
JPN	0.99	5		-1.91	8		-1.63	4	
KOR	1.33	9		-0.93	3	98:1	-0.84	4	98:1
MAL	-2.24	1	01:2 L	-1.95	1	98:1	-2.00	1	98:1
NZL	-3.08	6		-2.19	0	91:1	-2.17	4	91:1
PLP	-1.20	4	98:1 L, 86:1 T	-2.50	5	84:3	-2.73	4	84:3
SGP	-0.67	1		-2.10	1	85:2 L, 98:1 T	-2.86	1	
THL	-2.51	0		-1.37	0	98:1	-1.93	4	98:1
TWN	0.85	5		-1.31	6	01:1	-1.28	8	01:1
H_0 cannot be rejected at 10% significance level constant, trend and seasonal dummies included; L: level shift, T: trend shift									

Table 12: Unit root test statistics

	lags	shifts	impulse dummies	remarks	quarters
AUS	3		00:3,00:4,97:2		104
HK	6	98:1,00:3	85:2,98:3	00:3 trend shift	132
IDN	1		98:2,00:1	no trend	64
JPN	5	91:4	93:2,94:1,98:1	91:4 trend shift	104
KOR	6		97:2,98:1,03:3,03:4,05:3		104
MAL	0		95:3,95:4,98:1		60
NZL	4	91:1	91:1,98:2		75
PLP	4		88:4,98:1,98:2,98:4	no constant	100
SGP	1		94:2,98:1,02:3,03:2,03:3,05:1		104
THL	2		97:1,97:4,01:1	no trend	52
TWN	5		00:2,00:4,03:3,05:4	2-step estimation	104

Table 13: VECM specifications

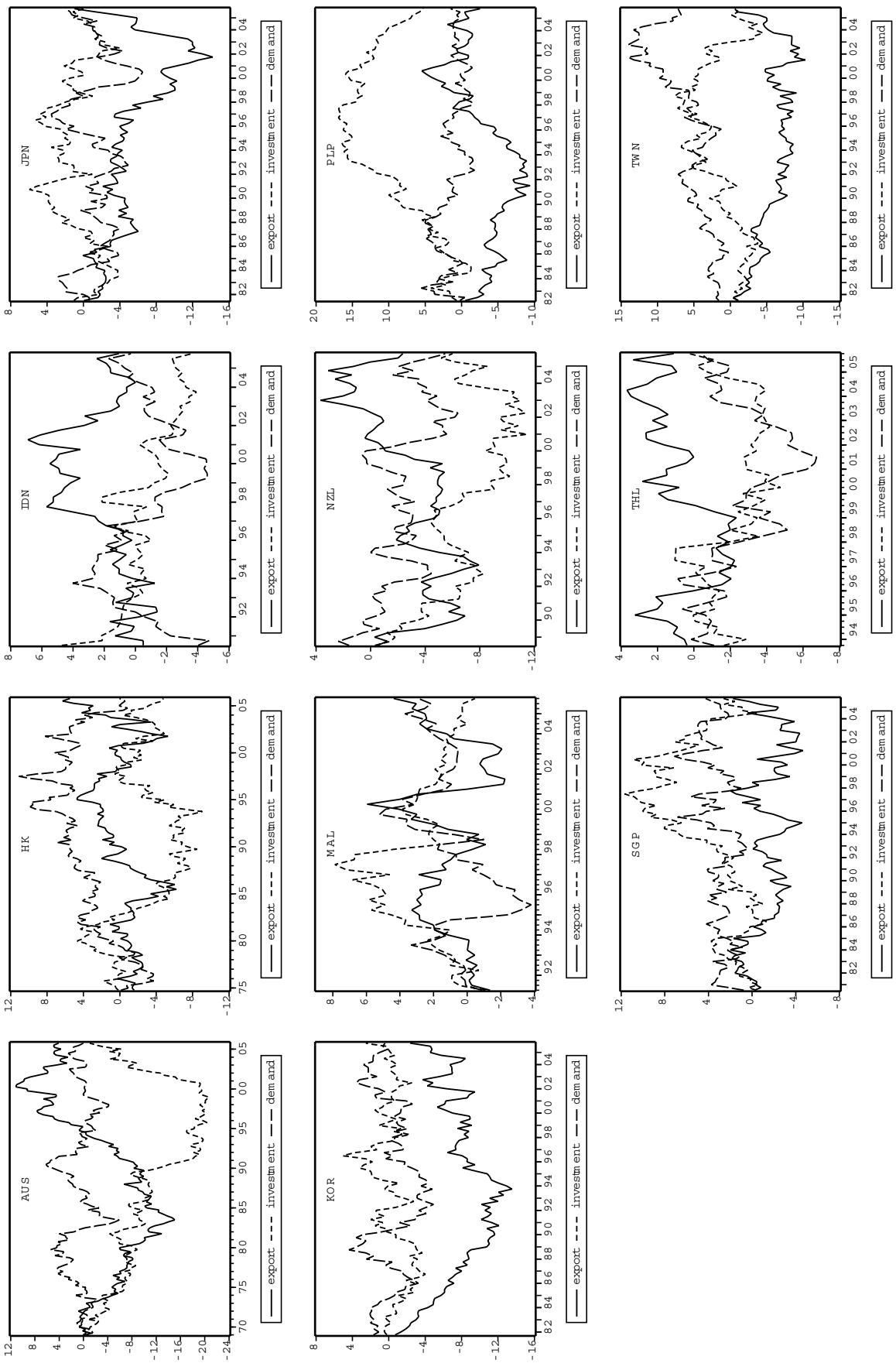

Figure 2: Accumulated structural shocks (in 2002 p.c. PPP US $)

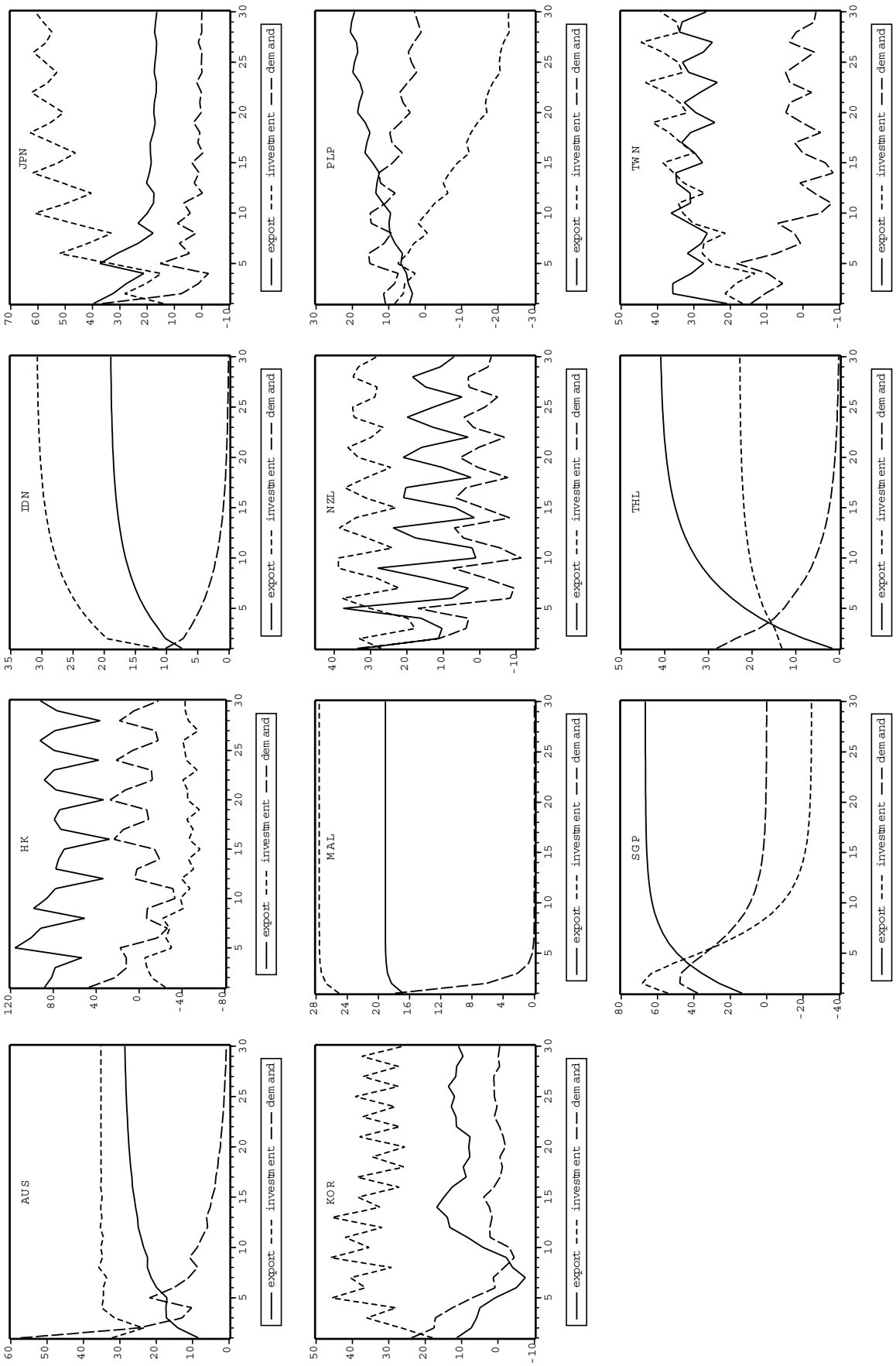

Figure 3: GDP responses to structural unit shocks (in 2002 p.c. PPP US $)